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A NEW ORNITHOMIMUS WITH COMPLETE ABDOMINAL CUIRASS¹

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INTRODUCTION

Fossilized remains of the Ornithomimidae are common in the Belly River and Edmonton formations of Alberta and the Lance formation of the western States but complete or nearly complete skeletons are very rare. Part of a skeleton of *Ornithomimus*, naturally articulated and splendidly preserved, was collected by G. F. Sternberg, in 1916, from the Edmonton formation of Alberta. This specimen is of special interest as it shows, for the first time, the complete set of abdominal ribs and their relationship to the thoracic ribs and the pectoral and pelvic arches. It also seems to show that there was a cartilaginous sternum.

The fine skeleton of *Struthiomimus altus* (Lambe) described by Professor H. F. Osborn,² gave a fair idea of the abdominal cuirass but did not prove the exact number of ribs or their relation to the coracoids and in Osborn's restoration the pectoral arch seems to have been brought too far back, thus abnormally shortening the body.

RELATIONSHIP

Ornithomimus velox, the genotype, was founded on the distal end of a tibia, astragalus, calcaneum, three metatarsals and digit II, from the Denver formation (probably of Lance age), near Denver, Colorado. Osborn proposed the new generic or subgeneric name for the reception of Lambe's *O. altus* from the Belly River formation of Alberta.³ His main reason for assigning the Belly River species to a distinct genus is its greater age and the presence of a vestigial fifth metatarsal. Gilmore observes that Osborn has not shown sufficient generic distinction and refers all the Ornithomimidae to the one genus, even those from the Arundel formation of Maryland.⁴ (The recently established genus and species *Macrophalangia cana-*

*densis*⁵ is, of course, very different from *Ornithomimus*.)

Parks has recently described a new species from the Edmonton formation as *Struthiomimus breviter-tius*⁶. He assigned his new species to *Struthiomimus* because of the presence of a vestigial fifth metatarsal.

The fact that no vestigial fifth metatarsal was found with the genotype does not seem to be proof that none was present in life. The specimen was evidently more or less disarticulated and the small metatarsal could easily become lost. In the specimen about to be described there is no sign of a scar on metatarsal IV or anything to suggest the presence of metatarsal V, but there is a fragment of bone with the specimen, which is very suggestive of part of a fifth metatarsal.

It is quite likely that when more is known of the Lance *Ornithomimus* it will show generic distinction between *Ornithomimus velox* and *Struthiomimus altus* but up to now sufficient distinctions have not been pointed out and the present specimen is referred to *Ornithomimus*. Osborn's generic name, however, will be retained for the present.

Ornithomimus edmontonicus sp. nov

Figures 1, 2 and 3.

Type: Cat. No. 8632 Geological Survey, Canada, consists of parts of three vertebrae; the greater portion of all the left thoracic ribs and the distal portions of those from the right side; the complete set of abdominal ribs; distal portions of both scapulae; complete coracoids; most of both pubes; complete right fore limb; left humerus; right tibia, fibula and pes; most of left femur, tibia and fibula and part of left pes.

Horizon and Locality: Edmonton formation near the middle of the beds on the west side of, and 100 feet above the level of, Red Deer River, 9 miles south-west of Morrin, Alberta.

Specific Characters: Medium sized; relatively

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² Amer. Mus. of Nat. Hist. Bull. 35 Art 43, pp. 738-761, pl. 26, 1916.

³ Loc. cit. p. 743.

⁴ Gilmore C. W., U. S. Nat. Mus., Bull. 110 pp. 129-144, 920.

⁵ Sternberg C. M. *Can. Field-Nat.* 46: 99-102, May 1932.

⁶ Parks W. A. *Trans. Roy. Soc. Can. Sec. IV* pp. 65-70 1926. The original spelling *S. breveter-tius* is evidently a topographical error.

slender; scapulæ and coracoids not coalesced; coracoids elongate; fore and aft expansion of pubes long and narrow, coalesced distally; abdominal ribs well developed but not fused, each half composed of moderately heavy ventral rib and one slender proximal splint; manus elongate;



FIGURE 1

Mtc. I longest and Mtc. III shortest, pollex, relatively long and slender; Mts. relatively slender; Mt. III complete proximally; phalanges of pes relatively elongate.

When compared with the genotype, *O. velox* Marsh, *O. edmontonicus* is larger, much more slender and the ascending astragalus process is longer and narrower. The three metatarsals of Marsh's type are but two-thirds as long as in our specimen though the breadth of each of the bones or of the three, articulated, is fully as great. The same is true of the tibia. It would thus seem that *O. velox* represented a much sturdier animal than *O. edmontonicus*.

Our new species differs from *S. brevitertius* Parks (*loc. cit.*) in the development of metatarsal III proximally; the more nearly uniform length of the metatarsals, the more elongate pes and the longer and narrower foot-like expansion of the pubis. As previously stated the presence of Mt. V is in doubt. Very little detailed information can be got from Parks' illustration so one must rely largely on the measurements as given.

Our femur is not complete but after comparison with the femur of *S. altus* I have estimated the complete length to be 380 mm. On this basis the femoro-tibial ratio is .835 while that of *S. brevitertius* is scarcely .81. The metatarso-tibial ratios are respectively .692 and .62 and that of the foot to the tibia 1.21 and 1.02. Reference to the comparative table of measurements shows that with one exception all of the phalanges of *O. edmontonicus* are longer than those of *S. brevitertius*.

When compared with *S. altus* our new species shows a more advanced stage of development of the abdominal ribs, a more slender and differently proportioned manus and more elongate phalanges of the pes.

DESCRIPTION

The three vertebræ which remain are in such a poor state of preservation that no information can be gained from them. The rest of the column with the skull and most of the pelvic arch was eroded away before discovery.

Ribs: Twelve thoracic ribs are represented and preserved in the rock (Figure 1) in what is regarded as their normal position. Each rib is represented by the distal half or more. This is probably the complete series as Osborn's restoration shows this number and Mr. Barnum Brown informs me (recent communication) that he regards the number of dorsals as twelve. If this is the complete dorsal series No. 2 was somewhat longer than in *S. altus* for it extends well below the blade of the scapula and No. 1 almost reaches it. Otherwise they rather closely resemble the thoracic ribs of Osborn's specimen and their position with relation

to each other and to the pectoral arch shows that the scapulæ and coracoids occupy their normal position thus leaving a considerable gap between the posterior edge of the coracoids and the anterior end of the abdominal ribs. Osborn's specimen shows a similar gap between these elements but in his restoration the coracoids are brought back to meet the abdominal ribs thus abnormally shortening the body. Probably the second and third thoracic ribs were attached to the sternum while the posterior ones were united with the abdominal ribs.

Sternum: There is no sign of an ossified sternum but the wide gap between the coracoids and the abdominal ribs suggests that the animal had a cartilaginous sternum. This gap is 120 mm. in length. In *Sphenodon* a semi-calcified sternum occupies a somewhat similar position and unites with some of the anterior ribs. Examination of the sternum of *Gorgosaurus libratus*⁷ suggests that it was poorly calcified and it is possible that in young animals it was cartilaginous.

Abdominal ribs: (Figure 1) The complete series of abdominal ribs is present, splendidly preserved and naturally articulated. There is some lateral compression of the posterior portion of this cuirass but otherwise the elements all seem to be in their normal position. There are fourteen ribs on the left side and fifteen on the right. Each rib is composed of two parts *i.e.* a long slender proximal and a stouter distal part. The abdominal ribs of *Struthiomimus altus* are composed of three segments. Gilmore regards the reduction of the number of segments as a progressive development (*loc. cit.* p. 146.) The proximal splint lies on the anterior face of the main bone and pinches out to thread-like proportions as it overlaps its thicker part. The proximal extremities of some of these are lost but they all seem to be shorter than the distal or main part of the rib. The distal piece is longer and much stouter. They are almost half as broad as the thoracic ribs except the proximal portion which ends in a long drawn out sliver where it overlaps the proximal piece and finally disappears. The ribs are more or less uniform except the last pair which are much less developed and lack the proximal splints. Of this last pair the right one is very short and poorly developed and its mate is bent forward to avoid the distal end of the pubis. There is a slight increase in size and a lessening of the space between the ribs from the front backward.

The ribs meet in the form of a V and no co-ossified or single median segment was present. They extended backward and outward somewhat as in *Sphenodon* thus giving a less rounded abdomen

⁷ See Lambe L. M. Mem. 100, Geol. Surv. Can. Figures 29-30, 1917.

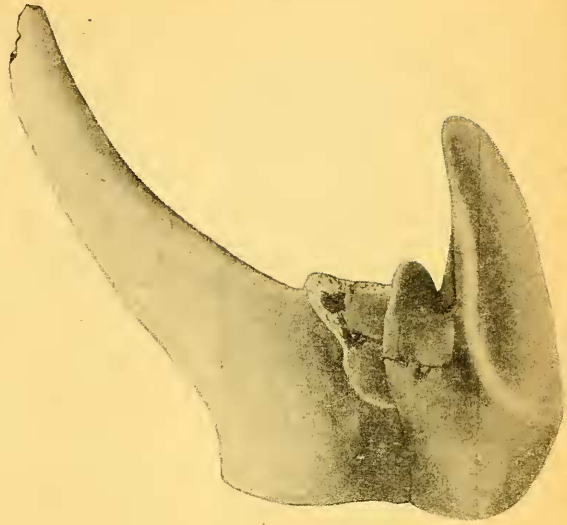


FIGURE 2

than that shown by Lambe for *Gorgosaurus* (*loc. cit.* Figure 27). They do not overlap and though the ends are slightly enlarged there is no rugose attachment area as in *Gorgosaurus*. At the ends of the series the tips of the ribs meet but in the fourth pair the right one extends in advance of its mate and from here to the sixth pair from the back the unions are irregular and there is an extra rib on the right side. Ribs five, six and seven of this side are more slender than the others.

MEASUREMENTS OF ABDOMINAL CUIRASS

Length of complete series of abdominal ribs (midline).....	470 mm.
Breadth, approximately.....	120 "
Posterior edge of coracoids to anterior abdominal rib.....	120 "
Posterior edge of coracoid to foot of pubis.....	600 "
Anterior edge of coracoid to posterior edge of foot of pubis.....	890 "

Scapula and Coracoid: (Figure 2.) The lower halves of the scapulæ and the complete coracoids are preserved. They are naturally articulated except that lateral crushing has caused an overlapping of the coracoids anteriorly and a slight shifting of the right coraco-scapular union (Figure 1, c.). They are not co-ossified.

The scapula was probably not unlike that of *S. altus*. Below the shaft, it expands abruptly forward then forms a broad sweeping curve to its union with the coracoid. This curve is continued by the broad anterior edge of the coracoid. This portion of the bone is very thin as is the anterior portion of the coracoid with which it unites. Posteriorly the scapula is slightly expanded and

thickened to form more than half of the glenoid cavity. This lower portion curves inward to its union with the coracoid thus suggesting a broad chest.

The coracoid is unlike that of most dinosaurs and at first glance somewhat suggests an ilium. It is twice as long as broad and the long posterior expansion is much narrower than the anterior portion. The posterior half decreases in breadth only slightly as it proceeds backward and terminates in a gently rounded extremity. It is quite thin throughout except where it is enlarged to form part of the glenoid cavity and the external border of the posterior extension. This external border is buttressed by a flange which extends from the postero-internal angle of the glenoid cavity, on the inner side of the bone to its posterior end. This is quite similar to the buttress on the lower postero-internal face of the ilium of *Gorgosaurus*. The external border of this posterior half runs to a thickened portion of the bone internal to the posterior edge of the glenoid cavity and near the center of the lower face of the coracoid. This flanging gives the postero-external portion of the bone the appearance of being deeply grooved longitudinally and sets it off from the glenoid cavity thickening by a sharp constriction. The internal border (at the midline of the body), is flatly convex, when viewed from below, and of uniform thinness throughout. The coracoid foramen is in advance of the glenoid cavity and not far removed from the coraco-scapular union.

MEASUREMENTS OF SCAPULA AND CORACOID

Scapula, breadth of shaft near midlength.....	26 mm.
" fore and aft length of distal expansion.....	63 "
" breadth of distal expansion.....	50 "
" thickness of distal expansion.....	2 "
Estimated breadth of chest.....	125 "
Coracoid, length (fore and aft).....	108 "
" breadth through anterior portion.....	43 "
" breadth through glenoid cavity.....	50 "
" breadth posterior extension.....	31 "
" average thickness inner portion.....	2½ "
" thickness through glenoid cavity.....	20 "
" thickness through buttresses, just behind glenoid cavity.....	17 "

Pubis: The foot-like distal expansion of the pubis meets its fellow in a symphysis but they are not co-ossified except for a short distance posteriorly. It is proportionately longer and more slender than in other described species. The total length of this foot-like expansion is 170mm. of which the anterior portion measures 40 mm. and the posterior portion 70 mm.

FORE LIMB

The humerus, radius and ulna are more slender than, but otherwise do not appear to differ greatly from, those of *S. altus* but the manus which is also more slender shows considerable variation. The ulna, radius and metacarpals are hollow and the crushed condition of the humerus suggests that it was also. (See Figure 3.)

Metacarpals I to III are very slender and firmly fitted to one another. There is no sign of a vestigial Mtc. IV as in *S. altus*. Mtc. I is much stouter and somewhat longer than the others and relatively longer than in *S. altus*. It is only slightly divergent distally. The distal ends of the metacarpals are broader than the proximal portions. The breadth of the three united metacarpals is proximally 30 mm., distally 45 mm. and at midlength 23 mm.



FIGURE 3

Whereas in *S. altus* digit II is longest and I is shortest, in *O. edmontonicus* they all reach an almost equal length. The penultimate and ungular phalanges seem most highly specialized in this species for in all three digits these are relatively longer and more slender than in *S. altus*. The penultimate phalanges are hollow and the bone wall is quite thin. Phalanges 1 of II and 1 and 2 of III have suffered postmortem crushing but no doubt were also hollow.

The extreme tips of the unguals were injured in collecting but their lengths can be determined with reasonable certainty. They are of sub-equal length, laterally compressed, slender, and almost straight except that of digit I, which is slightly decurved.

HIND LIMB

The hind limb does not differ greatly from that of *S. altus* except for the more elongate and relatively more slender pes and the more uniform length of Mts. II and IV. These characters are shown in the comparative measurements which follow.

Metatarsals III and IV were slightly misplaced and the proximal end of Metatarsal III is not preserved but the articulation surface on the inner and posterior sides of the other metatarsals and their postero-internal excavation shows that III was developed proximally.

The phalanges are relatively much longer than in *S. altus* and the ginglymoid facets are more strongly developed. The pes shows a highly developed cursorial type and would undoubtedly have been of little use as a grasping organ. The unguals are too badly crushed to show details.

EXPLANATION OF FIGURES

FIGURE 1. *Ornithomimus edmontonicus*. Type. Cat. No. 8632 Geological Survey of Canada. View to show abdominal cuirass and its relation to the rest of the skeleton. C, coracoid; 1-2-3-12, thoracic ribs; dotted line shows portion of tibia removed to show abdominal ribs. — Nat. size.

FIGURE 2. Coracoid and scapula of type No. 8632. Drawn by A. Miles. —Nat. size.

FIGURE 3. Fore limb of type No. 8632. Nat. size.

COMPARATIVE MEASUREMENTS

	<i>Ornithomimus edmontonicus</i>	Osborn's specimens of <i>Struthiomimus altus</i>	<i>Struthiomimus brevitertius</i>
	mm.	mm.	mm.
Rib: 1st. costal, length..	140+		
" 5th " " " ..	200e		
" 11th " " " ..	150+		
Humerus " " ..	280	310	
Ulna " " ..	215	230	
" proximal width... ..	20		
" distal " " ..	22		
Radius length	195		
Manus " " ..	264	315e	
Metacarpal I " " ..	90	85	
" II " " ..	84	100	
" III " " ..	83	95	
Digit I less Mtc. " " ..	167		
" II " " " ..	175		
" III " " " ..	175		
Digit I phalanx 1.....	107	110	
" I " " 2.....	65e	65	
" II " " 1.....	32	40	
" II " " 2.....	90	90	
" II " " 3.....	65	85	
" III " " 1.....	23	25	
" III " " 2.....	26	35	
" III " " 3.....	75	75	
" III " " 4.....	65	80	
Hind limb total length to tip of digit III.....	1350+ (1440e)	1530	1360
Femur length	310+	480	390
Tibia " "	455	540	483
Metatarsal I " "	300		252
" III " "	315e	370	293-203
" IV " "	310		273
Digit II (articulated) length	150	150	145
" III " " "	235	210	195
" IV " " "	155	150	140
" II phalanx 1 " "	83		73
" II " " 2 " "	41		34
" III " " 1 " "	76		70
" III " " 2 " "	63		58
" III " " 3 " "	48		40
" IV " " 1 " "	44		47
" IV " " 2 " "	38		30
" IV " " 3 " "	33		27
" IV " " 4 " "	30		21